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03 - Business tier

EJBs, managed objects, AOP, dependency injection, object pooling

AMT 2018

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Webcasts

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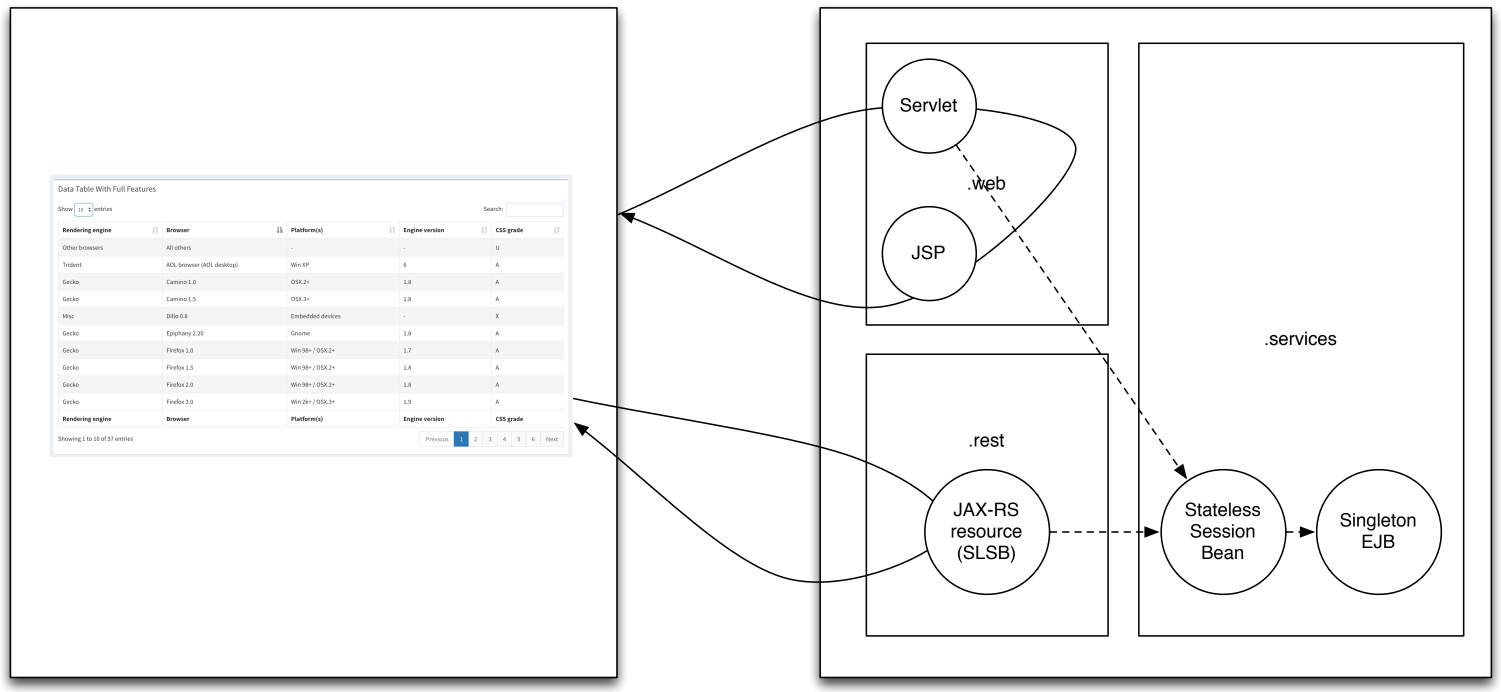
1 MVC - the browser asks for a an HTML page and its assets (css, js, etc.)



Data Table With Full Features

Show 10 entries Search:

Rendering engine	Browser	Platform(s)	Engine version	CSS grade
Other browsers	All others	-	-	U
Trident	AOL browser (AOL desktop)	Win XP	6	A
Gecko	Camino 1.0	OSX.2+	1.8	A
Gecko	Camino 1.5	OSX.3+	1.8	A
Misc	Dillo 0.8	Embedded devices	-	X
Gecko	Epiphany 2.20	Gnome	1.8	A
Gecko	Firefox 1.0	Win 98+ / OSX.2+	1.7	A
Gecko	Firefox 1.5	Win 98+ / OSX.2+	1.8	A
Gecko	Firefox 2.0	Win 98+ / OSX.2+	1.8	A
Gecko	Firefox 3.0	Win 2k+ / OSX.3+	1.9	A
Rendering engine	**Browser**	**Platform(s)**	**Engine version**	**CSS grade**

Showing 1 to 10 of 57 entries

Previous 1 2 3 4 5 6 Next

2 SPA - the data tables script invokes the REST API to get data (AJAX)

Tasks

1. Create a new project
1.1. the code deployed in Glassfish and Wildfly will be slightly different
1.2. for this reason, we will work in 2 branches: fb-rest-glassfish, fb-rest-wil

2. Implement the business services layer with EJBs
2.1. Implement a singleton EJB
2.2. Implement a stateless session bean
2.3. Inject the stateless session bean in a servlet

3. Implement a REST API with JAX-RS (Jersey and Jackson)
3.1. Configure the framework
3.2. Implement DTOs
3.3. Implement a REST endpoint
3.4. Test the REST endpoint

4. Build a UI on top of the REST API
4.1. Select and study a template
4.2. Discover jquery datatables
4.3. Integrate the template in the project

What is an EJB?
What are the different types of EJBS and how are they different from servlets (e.g. concurrency)?
What is dependency injection?
What is JAX-RS?

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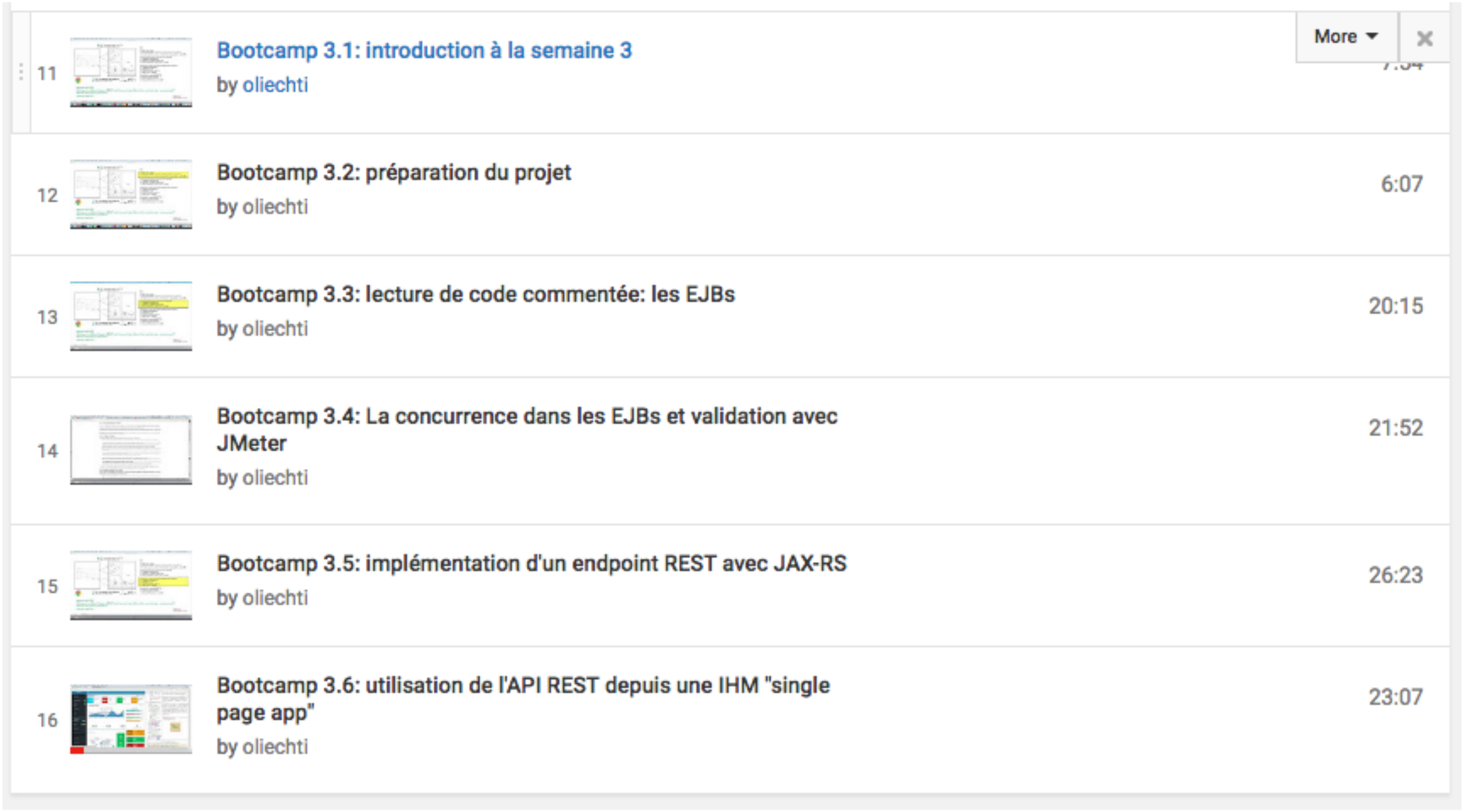

More

11	Bootcamp 3.1: introduction à la semaine 3 by oliechti	7:54
12	Bootcamp 3.2: préparation du projet by oliechti	6:07
13	Bootcamp 3.3: lecture de code commentée: les EJBs by oliechti	20:15
14	Bootcamp 3.4: La concurrence dans les EJBs et validation avec JMeter by oliechti	21:52
15	Bootcamp 3.5: implémentation d'un endpoint REST avec JAX-RS by oliechti	26:23
16	Bootcamp 3.6: utilisation de l'API REST depuis une IHM "single page app" by oliechti	23:07

Warning!

The webcast was recorded for another edition of the course.
This year, the planning is a bit different.

Some of the topics will be presented later:

- REST APIs with JAX-RS
- Data Transfer Objects (DTOs)
- Single Page App

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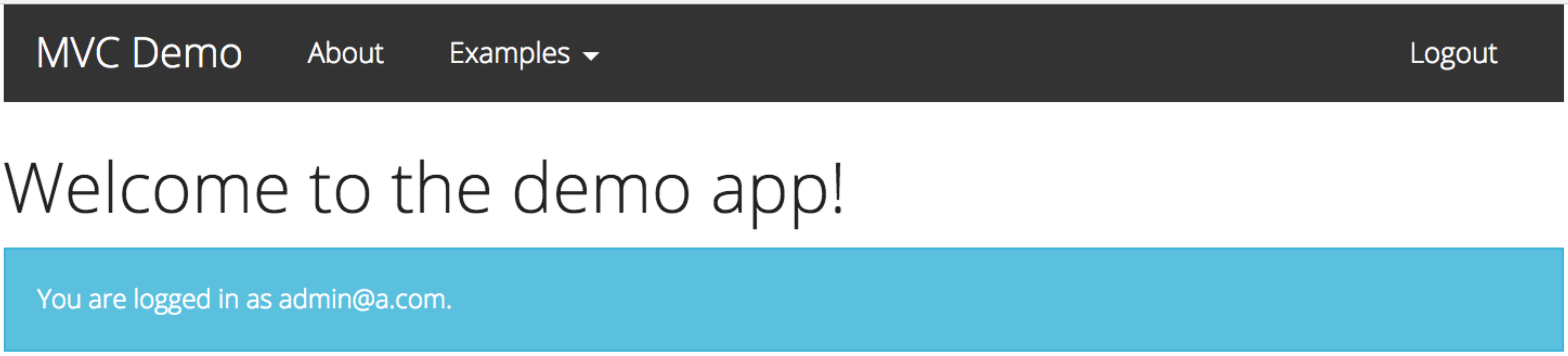
MVC demo application

https://github.com/SoftEng-HEIGVD/Teaching-HEIGVD-AMT-Example-MVC

checkout MVC-EJB-Concurrency-NoDB



Welcome to the demo app!

You are logged in as admin@a.com.

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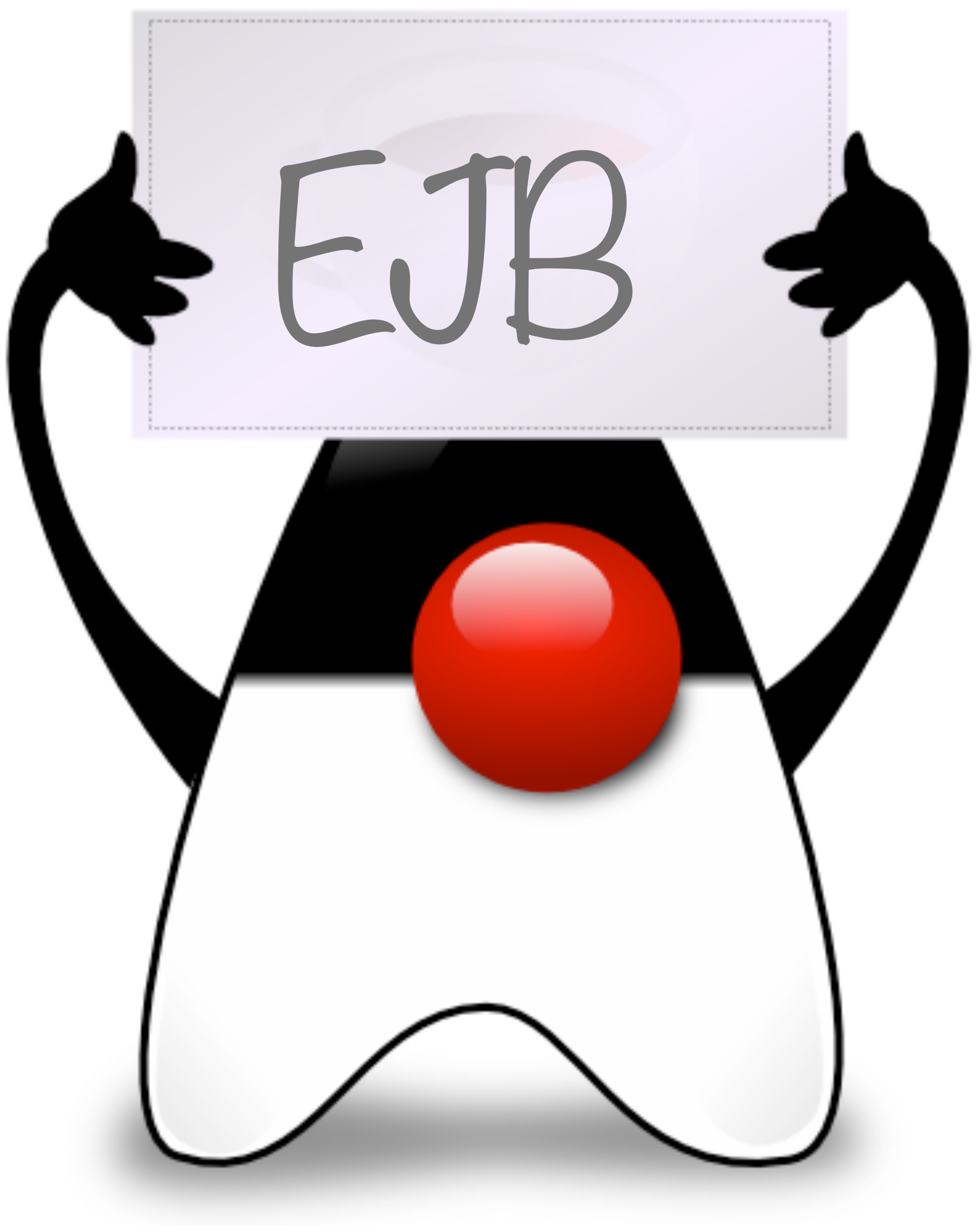

Business Services & EJB

Services in a Java EE application

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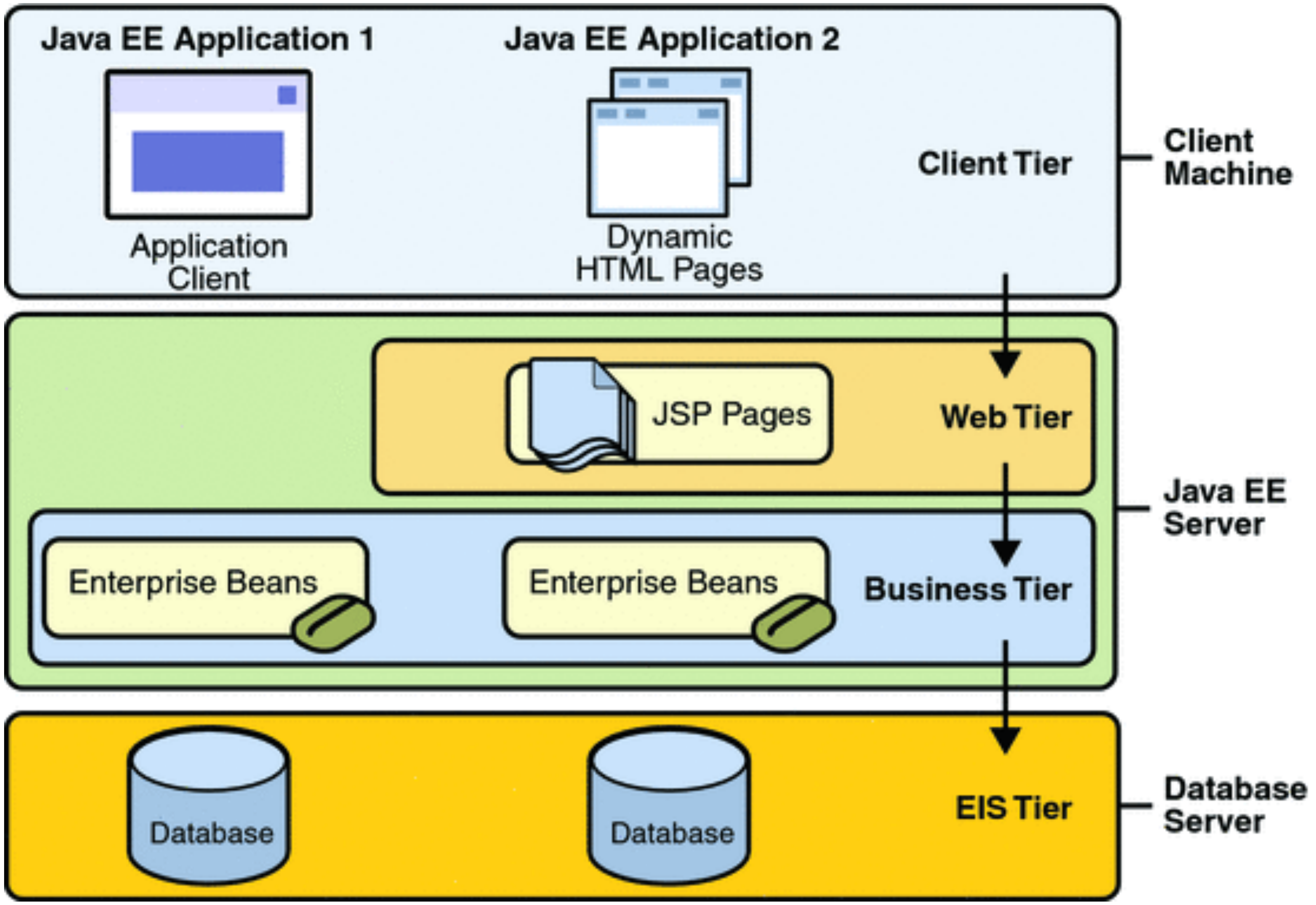
- Last week, we implemented a very simple Java EE application.
- When we implemented the MVC pattern, we implemented a service as a **Plain Old Java Object** (POJO).
- **The POJO was not a managed component.** We created the instance(s) of the service (*in the web container*).
- This week, we will see an **alternative solution** for implementing Java EE services: Enterprise Java Beans (EJBs).

What is the best way to implement services, POJOs or EJBs? **There is not a single right answer to this question!** There are pros and cons in both approach.



http://java.sun.com/javaee/5/docs/tutorial/doc/bnaay.html

What is an **Enterprise Java Bean** (EJB)?

- An EJB is a **managed component**, which implements **business logic** *in a UI agnostic way*.
- The EJB container manages the **lifecycle** of the EJB instances.
- The EJB container also **mediates the access** from clients (i.e. it is an “invisible” intermediary) to EJBs. This is a form of Aspect Oriented Programming (AOP):
- This allows the EJB container to perform technical operations (especially related to **transactions** and **security**) when EJBs are invoked by clients.
- The EJB container manages a **pool** of EJB instances.
- Note: the EJB 3.2 API is **specified is JSR 345**.

What are the **4 types** of EJBs used today?

- **Stateless Session Beans** are used to implement business services, where every client request is independent.
- **Stateful Session Beans** are used for services which have a notion of conversation (e.g. shopping cart).
- **Singleton Session Beans** are used when there should be a single service instance in the app.
- **Message Driven Beans** are used together with the Java Message Service (JMS). Business logic is not invoked when a web client sends a request, but when a message arrives in a queue. We will see that later.

When you implement a stateful application in Java EE, **you have the choice to store the state in different places**. One option is to do it in the web tier (in the HTTP session). Another option is to use **Stateful Session Beans**. Many (most) developers use HTTP sessions.

In older versions of Java EE (before Java EE 5), there was another type of EJBs: **Entity Beans**.

Entity Beans were used for **accessing the database**. They were a nightmare to use and raised a number of issues. You might find them in legacy applications.

Entity Beans (as a legacy type of EJB) are **not the same thing** as **JPA Entities**, which are now widely used!

A first example

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```
package ch.heigvd.amt.lab1.services;
import javax.ejb.Local;

@Local
public interface CollectorServiceLocal {

  void submitMeasure(Measure measure);

}
```

These **annotations** are processed by the application server at **deployment time**.

```
package ch.heigvd.amt.lab1.services;
import javax.ejb.Stateless;

@Stateless
public class CollectorService implements CollectorServiceLocal {

  @Override
  public void submitMeasure(Measure measure) {
    // do something with the measure (process, archive, etc.)
  }

}
```

They are an **declaration** that the service must be handled as a **managed component**!

How does a “client” find and use an EJB?

- By “**client**”, we refer to a **Java component** that wants to get a reference to the EJB and invoke its methods.
- In many cases, the client is a **servlet** or **another EJB** (i.e. a service that delegates part of the work to another service).
- The application server is providing a **naming and directory service** for managed components. Think of it as a “white pages” service that keeps track of component names and references.
- Remember that we mentioned **Dependency Injection** earlier today?

The Java Naming and Directory Interface (JNDI) provides an API to access directory services. It can be used to access an LDAP server. It can also be used to lookup components in a Java EE server.

The **first method** to find an EJB is to do an **explicit lookup**, with JNDI.

```
@WebServlet(name = "FrontController", urlPatterns = {"/FrontController"})
public class FrontController extends HttpServlet {

  private CollectorServiceLocal collectorService;

  @Override
  public void init() throws ServletException {
    super.init();
    try {
     Context ctx = new InitialContext();
     collectorService = (CollectorServiceLocal) ctx.lookup("java:module/CollectorService");
    } catch (NamingException ex) {
      Logger.getLogger(FrontController.class.getName()).log(Level.SEVERE, null, ex);
    }
  }
```

This gives me access to the app server's naming service

I am using the app server's naming service

Warning! These 2 JNDI operations are **costly** (performance-wise). You don't want to re-execute them for every single HTTP request!!!!
It is much better to do it once and to **cache the references** to the services.

The **second method** is to ask the app server to **inject a dependency** to the service.

```
@WebServlet(name = "FrontController", urlPatterns = {"/FrontController"})
public class FrontController extends HttpServlet {

  @EJB
  private CollectorServiceLocal collectorService;

}
```

With the @EJB annotation, **I am declaring a dependency** from between my servlet and my service. The servlet *uses* the service.

With the @EJB annotation, I am also giving instructions to the app server. The servlet and the service are **managed components**. When the app server instantiates the servlet, it **injects a value** into the **collectorService** variable.

EJBs in the MVCDemo project

```
@Singleton
public class BeersDataStore implements BeersDataStoreLocal {

 private final List<Beer> catalog = new LinkedList<>();

 public BeersDataStore() {
    catalog.add(new Beer("Cardinal", " Feldschlösschen", "Switzlerland", "Lager"));
    catalog.add(new Beer("Punk IPA", " BrewDog", "Scotland", "India Pale Ale"));
 }
...
}
```

```
@Stateless
public class BeersManager implements BeersManagerLocal {

  @EJB
  BeersDataStoreLocal beersDataStore;

  @Override
  public List<Beer> getAllBeers() {
    simulateDatabaseDelay();
    return beersDataStore.getAllBeers();
  }
...
}
```

EJBs in the MVCDemo project

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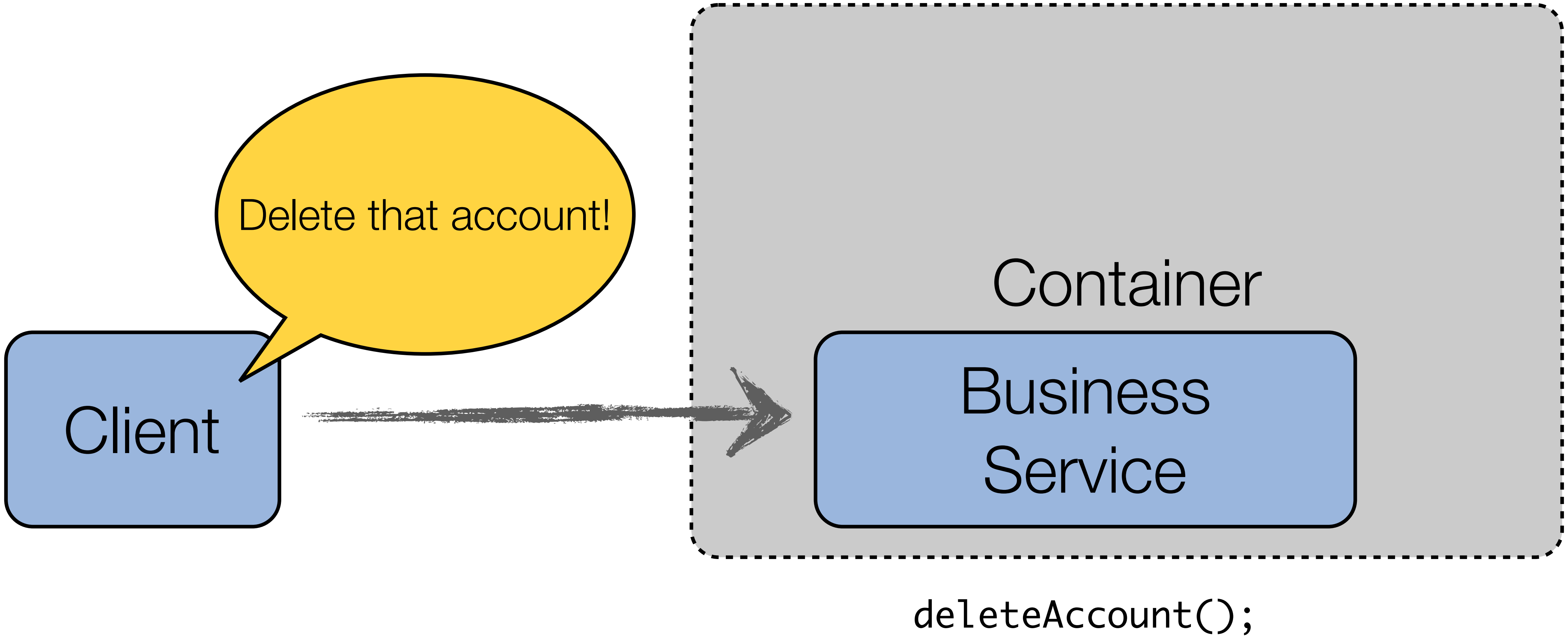
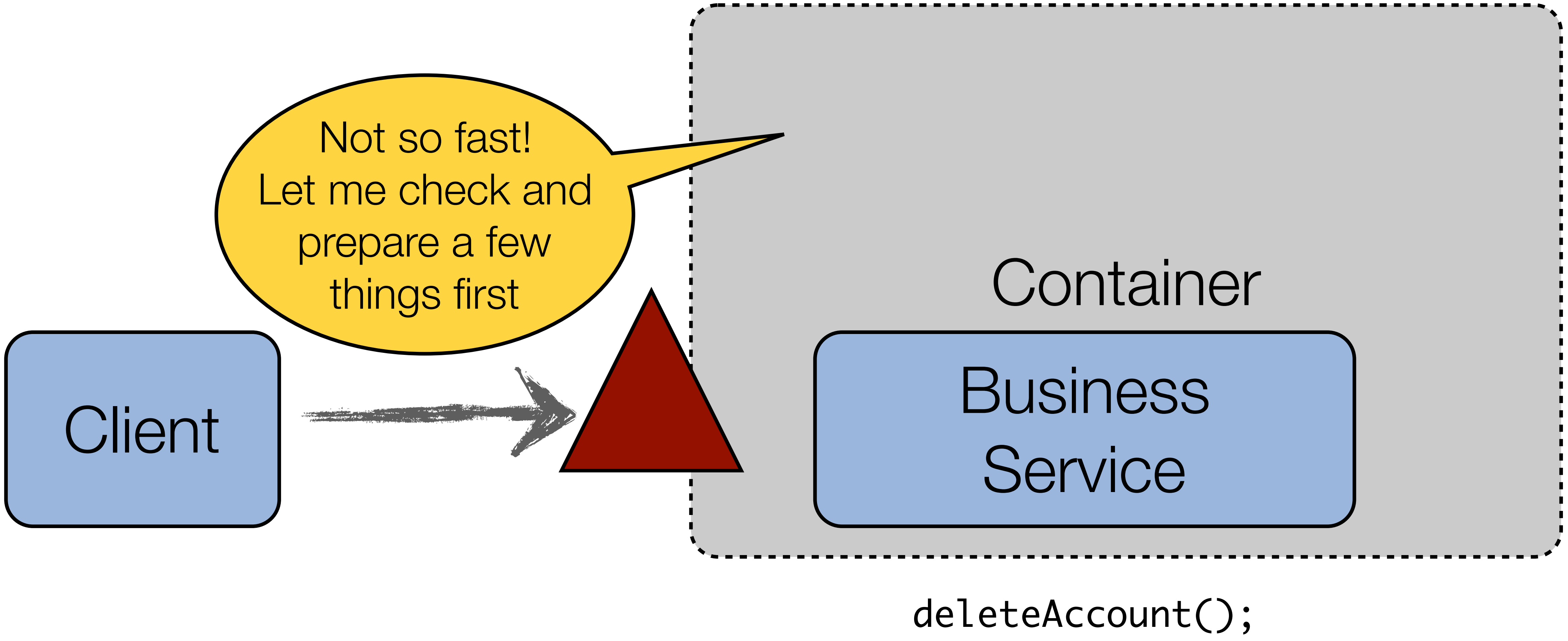
```
public class BeersServlet extends HttpServlet {

  @EJB
  BeersManagerLocal beersManager;

  @Override
  protected void doGet(HttpServletRequest request, HttpServletResponse response)
     throws ServletException, IOException {
    /*
     Firstly, we need to get a model. It is not the responsibility of the servlet
     to build the model. In other words, you should avoid to put business logic
     and database access code directly in the controller. In this example, the
     beersManager takes care of the model construction.
     */
    Object model = beersManager.getAllBeers();
    ...
   }
   ...
}
```

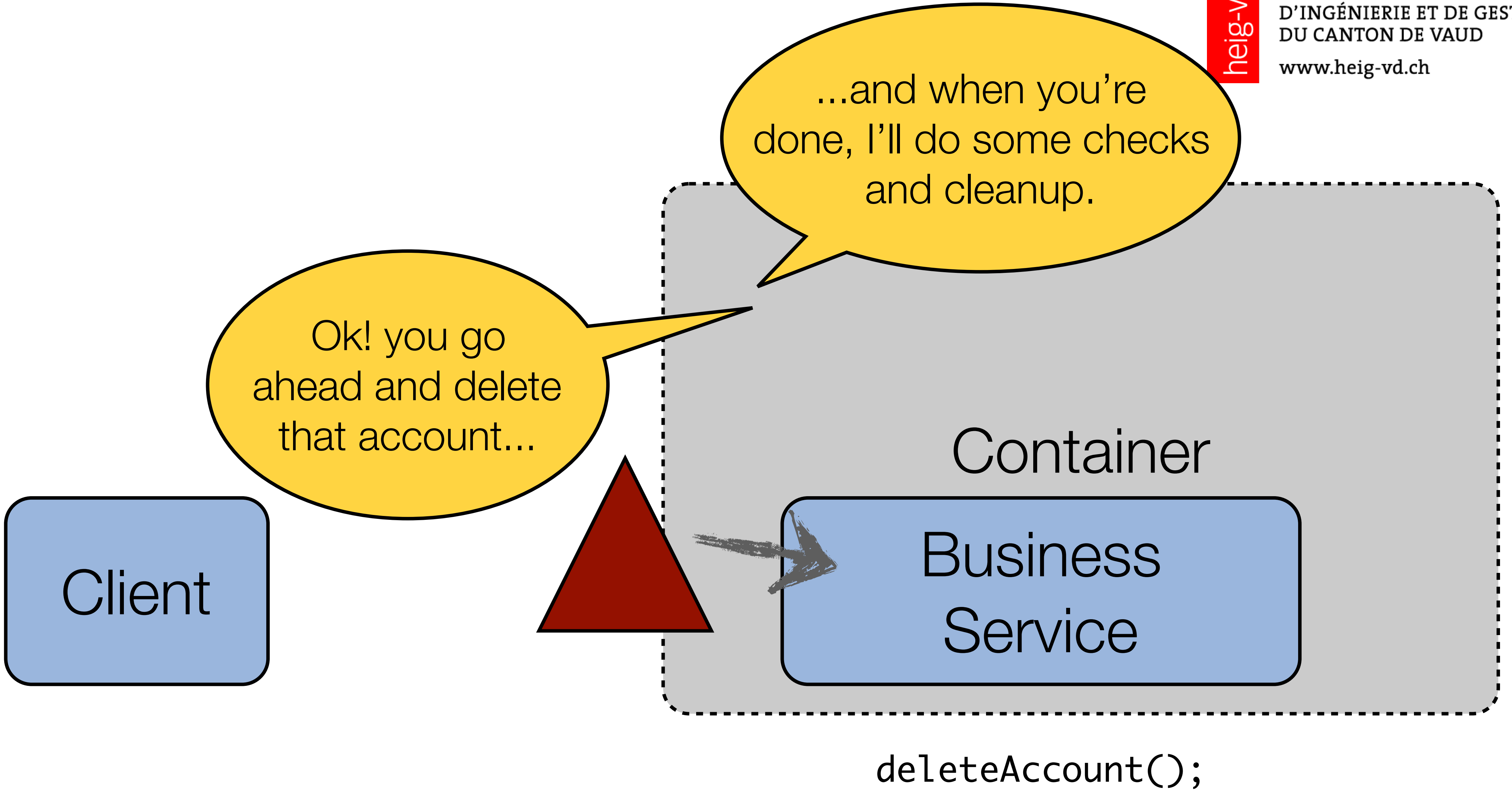
The app server **mediates** the access between clients and EJBs. What does it mean?



The business service, implemented as a Stateless Session Bean, is a **managed component**.
The client ***thinks*** that he has a direct reference to a Java object.
He is ***wrong***.



In reality, when the client invokes the deleteAccount() methods, the call is going **through the container**.
The container is in a position to **perform various tasks** (security checks, transaction demarcation, etc.)


...and when you're done, I'll do some checks and cleanup.
Ok! you go ahead and delete that account...
Container
Client
Business Service
deleteAccount();

When done, the container can forward the method call to the business service (your implementation).
On the way back, the response also goes back **via the container**.

How is that possible?
How does it work?

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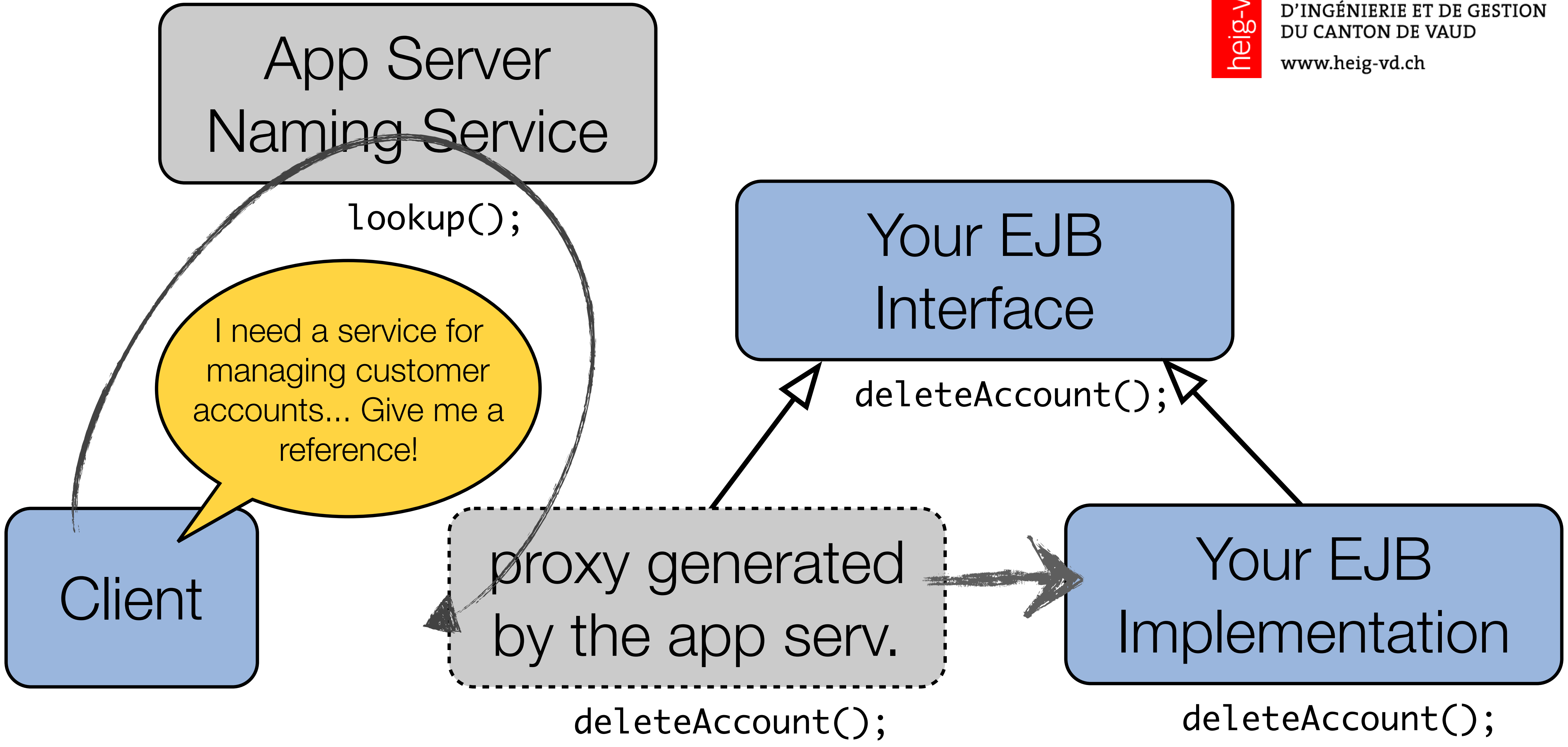
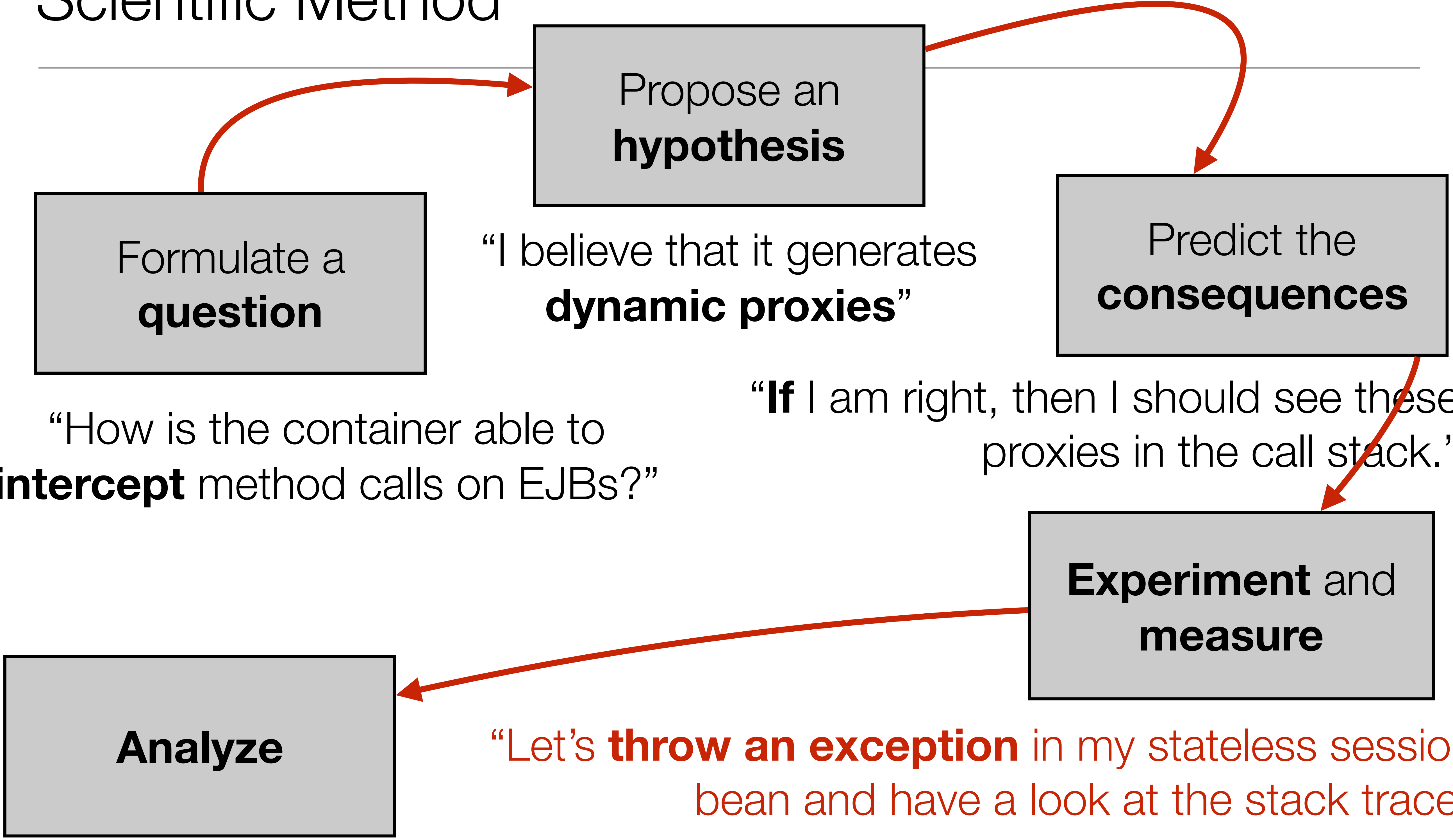

App Server Naming Service
lookup();
I need a service for managing customer accounts... Give me a reference!
Client
proxy generated by the app serv.
deleteAccount();
Your EJB Interface
deleteAccount();
Your EJB Implementation
deleteAccount();

Your service implementation implements your interface. **The container dynamically generates a class**, which implements the same interface. This class performs the technical tasks and invokes your class (proxy).

Scientific Method


Formulate a **question**
Propose an **hypothesis**
Predict the **consequences**
Experiment and **measure**
Analyze

"How is the container able to **intercept** method calls on EJBs?"

"I believe that it generates **dynamic proxies**"

"**If** I am right, then I should see these proxies in the call stack."

"Let's **throw an exception** in my stateless session bean and have a look at the stack trace"

"In the stack trace, I can confirm that the servlet is not directly calling my Stateless Session Bean implementation class."

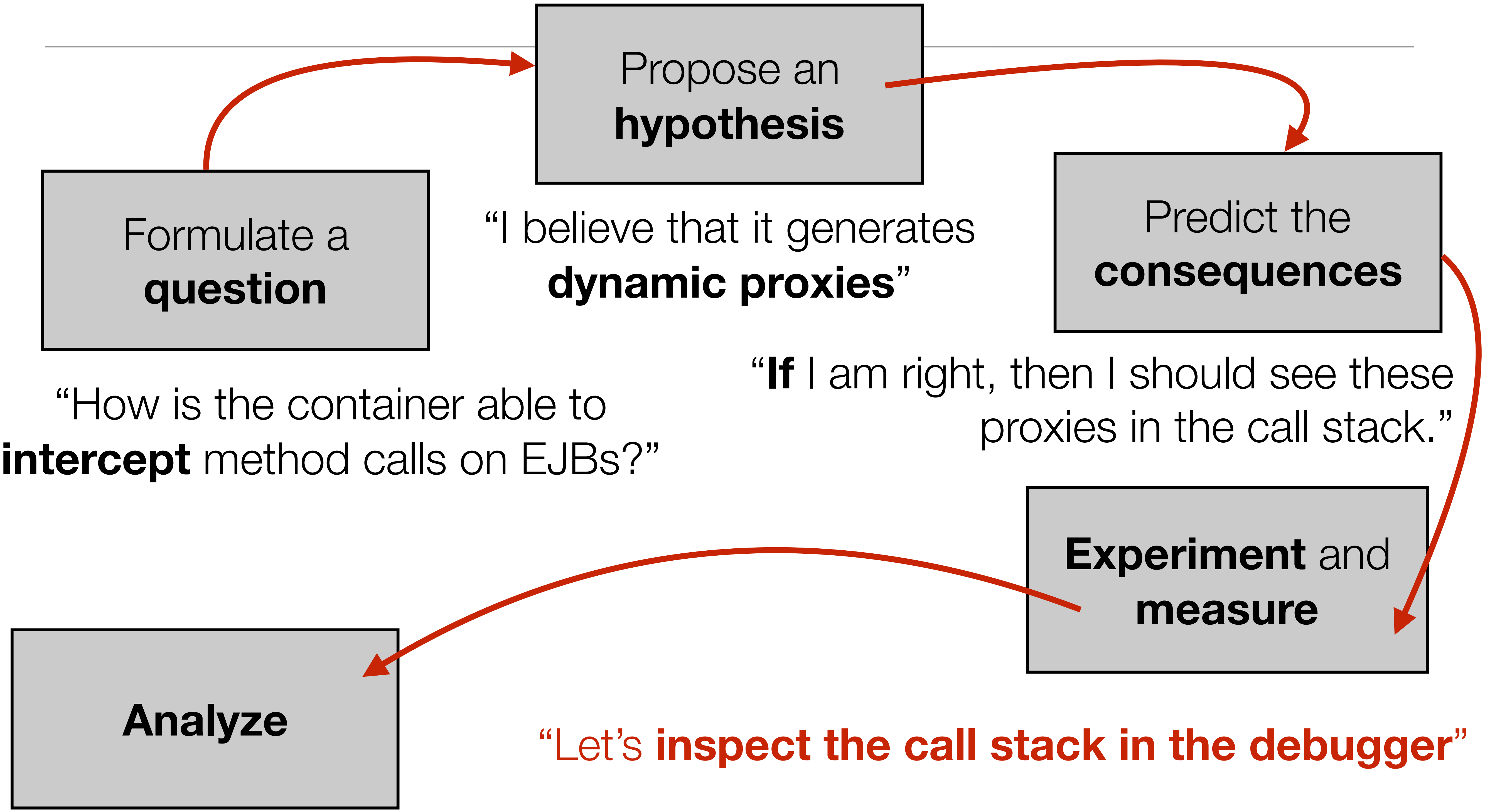
```
Caused by: java.lang.RuntimeException: just kidding
	at ch.heigvd.amt.lab1.services.CollectorService.submitMeasure(CollectorService.java:15)
	at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
	at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
	at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
	at java.lang.reflect.Method.invoke(Method.java:483)
	at org.glassfish.ejb.security.application.EJBSecurityManager.runMethod(EJBSecurityManager.java:1081)
	at org.glassfish.ejb.security.application.EJBSecurityManager.invoke(EJBSecurityManager.java:1153)
	at com.sun.ejb.containers.BaseContainer.invokeBeanMethod(BaseContainer.java:4786)
	at com.sun.ejb.EjbInvocation.invokeBeanMethod(EjbInvocation.java:656)
	at com.sun.ejb.containers.interceptors.AroundInvokeChainImpl.invokeNext(InterceptorManager.java:822)
	at com.sun.ejb.EjbInvocation.proceed(EjbInvocation.java:608)
	at
org.jboss.weld.ejb.AbstractEJBRequestScopeActivationInterceptor.aroundInvoke(AbstractEJBRequestScopeActivationInterceptor.java:46)
	at org.jboss.weld.ejb.SessionBeanInterceptor.aroundInvoke(SessionBeanInterceptor.java:52)
	at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
	at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
	at sun.reflect.DelegatingMethodAcc
	at java.lang.reflect.Method.invoke(M
	at com.sun.ejb.containers.intercepto
	at com.sun.ejb.containers.intercepto
	at com.sun.ejb.EjbInvocation.procee
	at com.sun.ejb.containers.intercepto
	at com.sun.ejb.containers.intercepto
	at sun.reflect.NativeMethodAccesso
	at sun.reflect.NativeMethodAccesso
	at sun.reflect.DelegatingMethodAcc
	at java.lang.reflect.Method.invoke(M
	at com.sun.ejb.containers.interceptors.AroundInvokeInterceptor.intercept(InterceptorManager.java:883)
	at com.sun.ejb.containers.interceptors.AroundInvokeChainImpl.invokeNext(InterceptorManager.java:822)
	at com.sun.ejb.containers.interceptors.InterceptorManager.intercept(InterceptorManager.java:369)
	at com.sun.ejb.containers.BaseContainer.__intercept(BaseContainer.java:4758)
	at com.sun.ejb.containers.BaseContainer.intercept(BaseContainer.java:4746)
	at com.sun.ejb.containers.EJBLocalObjectInvocationHandler.invoke(EJBLocalObjectInvocationHandler.java:212)
	... 34 more
```

```java
@Stateless
public class CollectorService implements CollectorServiceLocal {

  @Override
  public void submitMeasure(Measure measure) {
    throw new RuntimeException("just kidding");
  }

}
```

Scientific Method


Formulate a **question**
Propose an **hypothesis**
Predict the **consequences**
Experiment and **measure**
Analyze

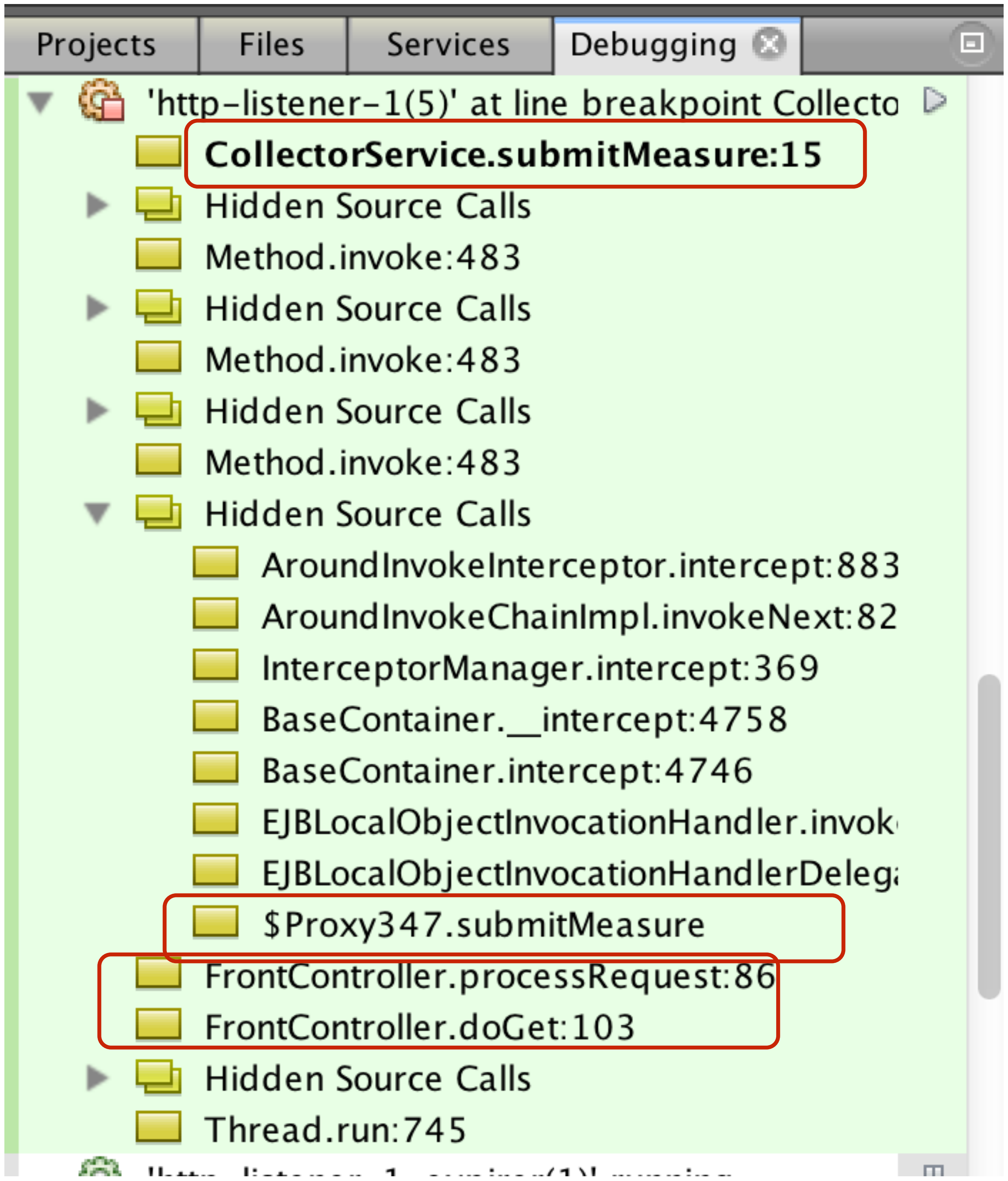
“How is the container able to **intercept** method calls on EJBs?”

“I believe that it generates **dynamic proxies**”

“**If** I am right, then I should see these proxies in the call stack.”

“Let’s **inspect the call stack in the debugger**”

“In the debugger console, I can confirm that there are container generated classes between my servlet and my service implementation.”



```
'http-listener-1(5)' at line breakpoint Collecto
    CollectorService.submitMeasure:15
  ▶ Hidden Source Calls
    Method.invoke:483
  ▶ Hidden Source Calls
    Method.invoke:483
  ▶ Hidden Source Calls
    Method.invoke:483
  ▼ Hidden Source Calls
      AroundInvokeInterceptor.intercept:883
      AroundInvokeChainImpl.invokeNext:82
      InterceptorManager.intercept:369
      BaseContainer.__intercept:4758
      BaseContainer.intercept:4746
      EJBLocalObjectInvocationHandler.invok
      EJBLocalObjectInvocationHandlerDeleg
      $Proxy347.submitMeasure
    FrontController.processRequest:86
    FrontController.doGet:103
  ▶ Hidden Source Calls
    Thread.run:745
```

At some point, the method call is forwarded to my implementation.

The reference actually points to a proxy generated by the container. The container performs tasks that are visible in a **long call stack**!

My servlet invokes the method on its **reference** to the EJB.

*An HTTP request has arrived; GF invokes the doGet callback on my servlet (**IoC**). GF has also **injected** a **reference** to the EJB into the servlet.*

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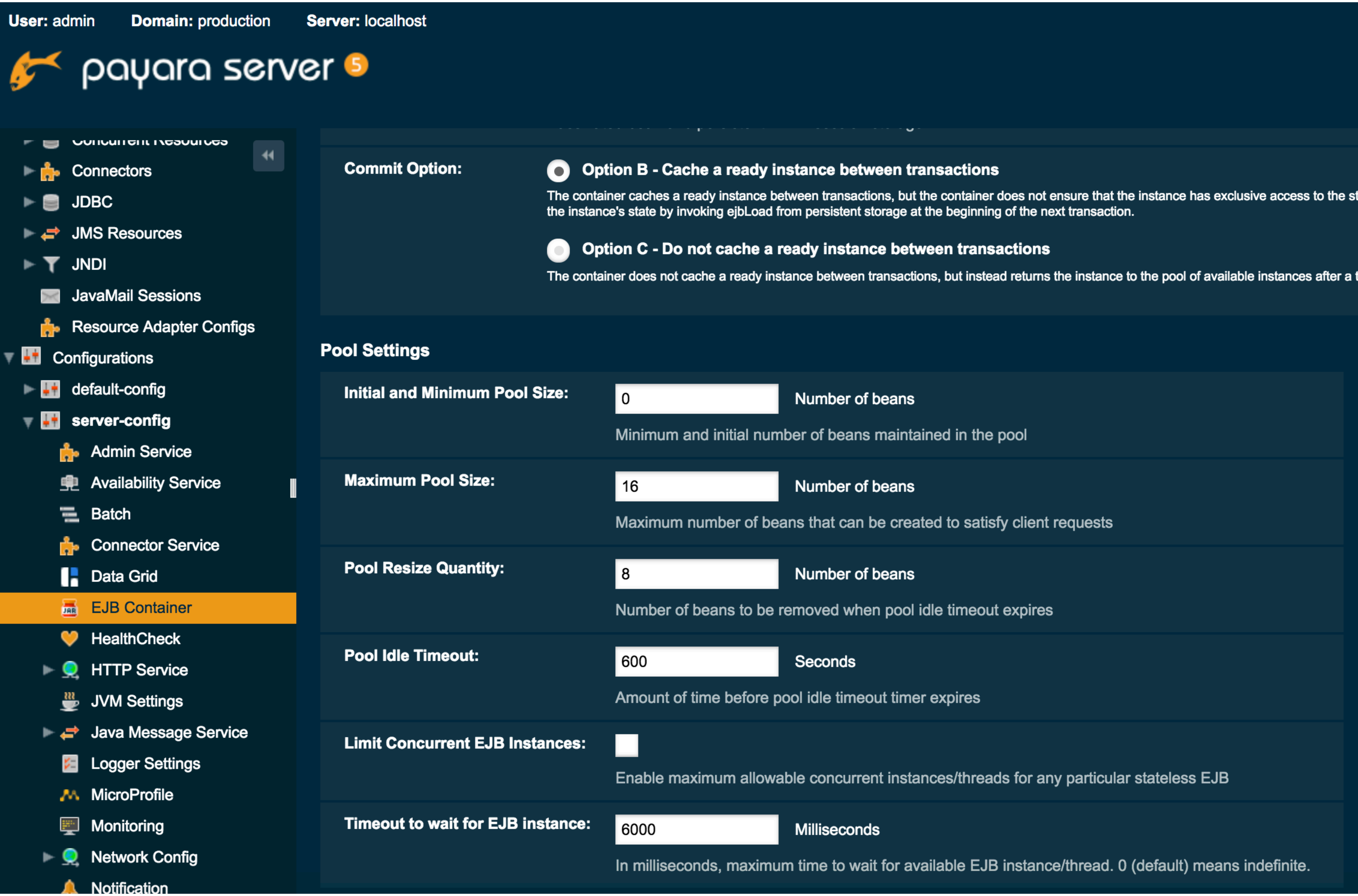
The book talks about pooling... what does it mean and why is it useful?


User: admin **Domain:** production **Server:** localhost

Commit Option:

[✓ **Option B - Cache a ready instance between transactions**]
The container caches a ready instance between transactions, but the container does not ensure that the instance has exclusive access to the st
the instance's state by invoking ejbLoad from persistent storage at the beginning of the next transaction.

Option C - Do not cache a ready instance between transactions
The container does not cache a ready instance between transactions, but instead returns the instance to the pool of available instances after a t

Pool Settings

Initial and Minimum Pool Size:	0	Number of beans
	Minimum and initial number of beans maintained in the pool	
Maximum Pool Size:	16	Number of beans
	Maximum number of beans that can be created to satisfy client requests	
Pool Resize Quantity:	8	Number of beans
	Number of beans to be removed when pool idle timeout expires	
Pool Idle Timeout:	600	Seconds
	Amount of time before pool idle timeout timer expires	
Limit Concurrent EJB Instances:	☐	
	Enable maximum allowable concurrent instances/threads for any particular stateless EJB	
Timeout to wait for EJB instance:	6000	Milliseconds
	In milliseconds, maximum time to wait for available EJB instance/thread. 0 (default) means indefinite.	

Why pool objects?

There are 2 main reasons for pooling objects

- To increase performance. Some objects take a long time to be created and initialized (e.g. DB connection object). It's better to reuse objects instead of throwing them away and recreating them.
- To set a limit on resource consumption (CPU, RAM). Under heavy load, we decide how many requests we process at the same time. It's better to have clients wait bit than to exhaust all server resources.

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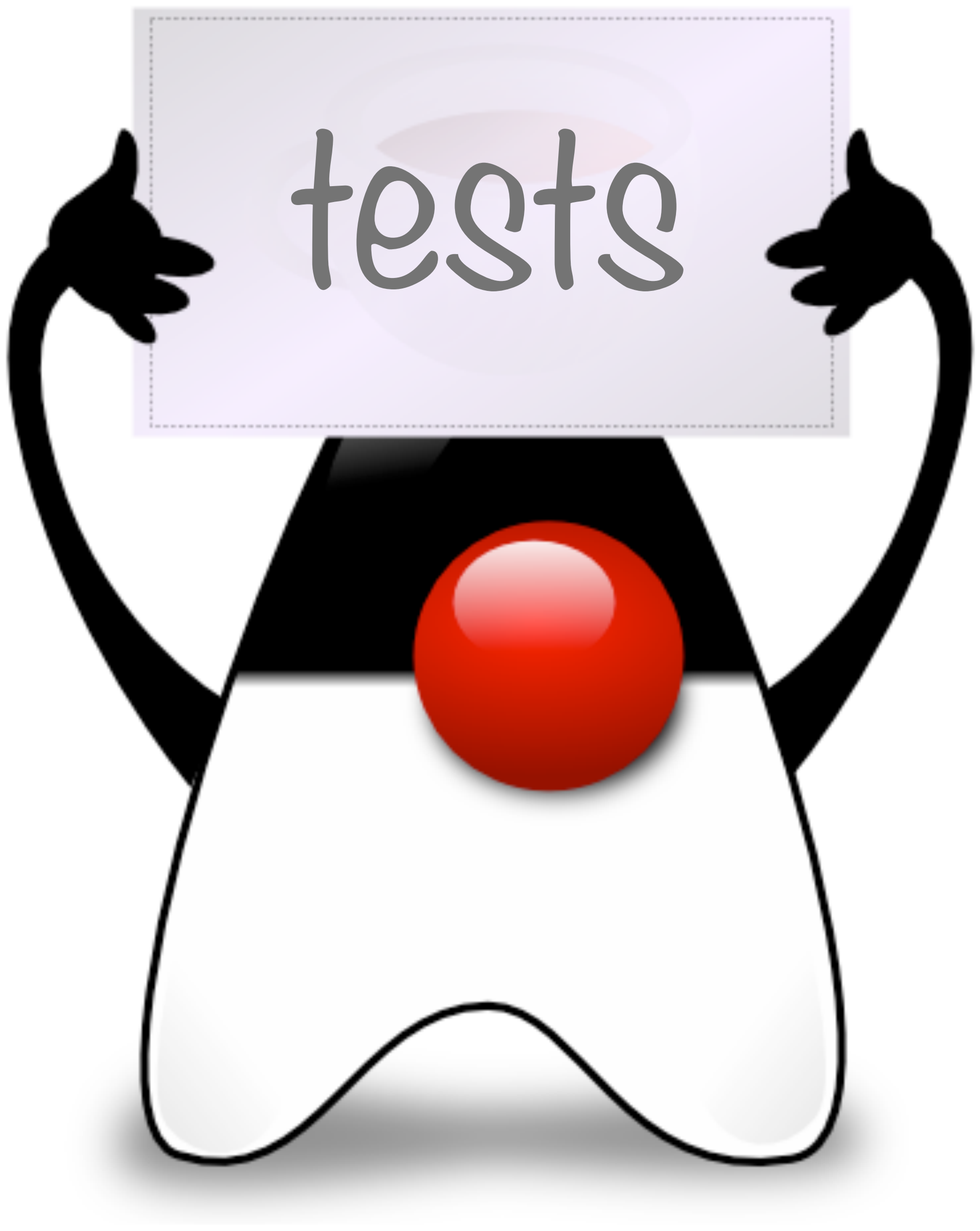

Experiment with JMeter

Challenge

Design an experiment to:

- prove that the application server manages pools of Stateless Session Beans (multiple instances)
- measure how the size of the pool impacts the throughput of the application
- measure how the size of the pool impacts the resource consumption (RAM, CPU)

Hints

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You should use a combination of tools

- JMeter to generate the load
- VisualVM (or JConsole) to monitor resource consumption on the server (container) and client (jmeter) side.
- You can use tricks in the code to simulate a time consuming task (Thread.sleep), or a resource hungry task (allocate dummy objects).

JMeter

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- Open source project, apache foundation
- http://jmeter.apache.org/index.html

“The Apache JMeter™ desktop application is open source software, a 100% pure Java application designed to ***load test functional behavior*** *and* ***measure performance****.*
It was originally designed for ***testing Web Applications*** *but has since* ***expanded to other*** *test functions.”*